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(54) **ADVANCED MISTING DELIVERY SYSTEM, METHODS, AND MATERIALS**

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(51) **Int. Cl.**

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A62C 35/15	(2006.01)
A62C 37/10	(2006.01)
A62C 37/40	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***A62C 35/13*** (2013.01); ***A62C 35/15*** (2013.01); ***A62C 37/10*** (2013.01); ***A62C 37/40*** (2013.01); ***B05B 1/02*** (2013.01); ***B05B 3/08*** (2013.01)

(58) **Field of Classification Search**

CPC A62C 3/002; A62C 3/006; A62C 3/008; A62C 25/00; A62C 35/026; A62C 35/13; A62C 35/15; A62C 37/10; A62C 37/11; A62C 37/40; B05B 1/02; B05B 3/08

See application file for complete search history.

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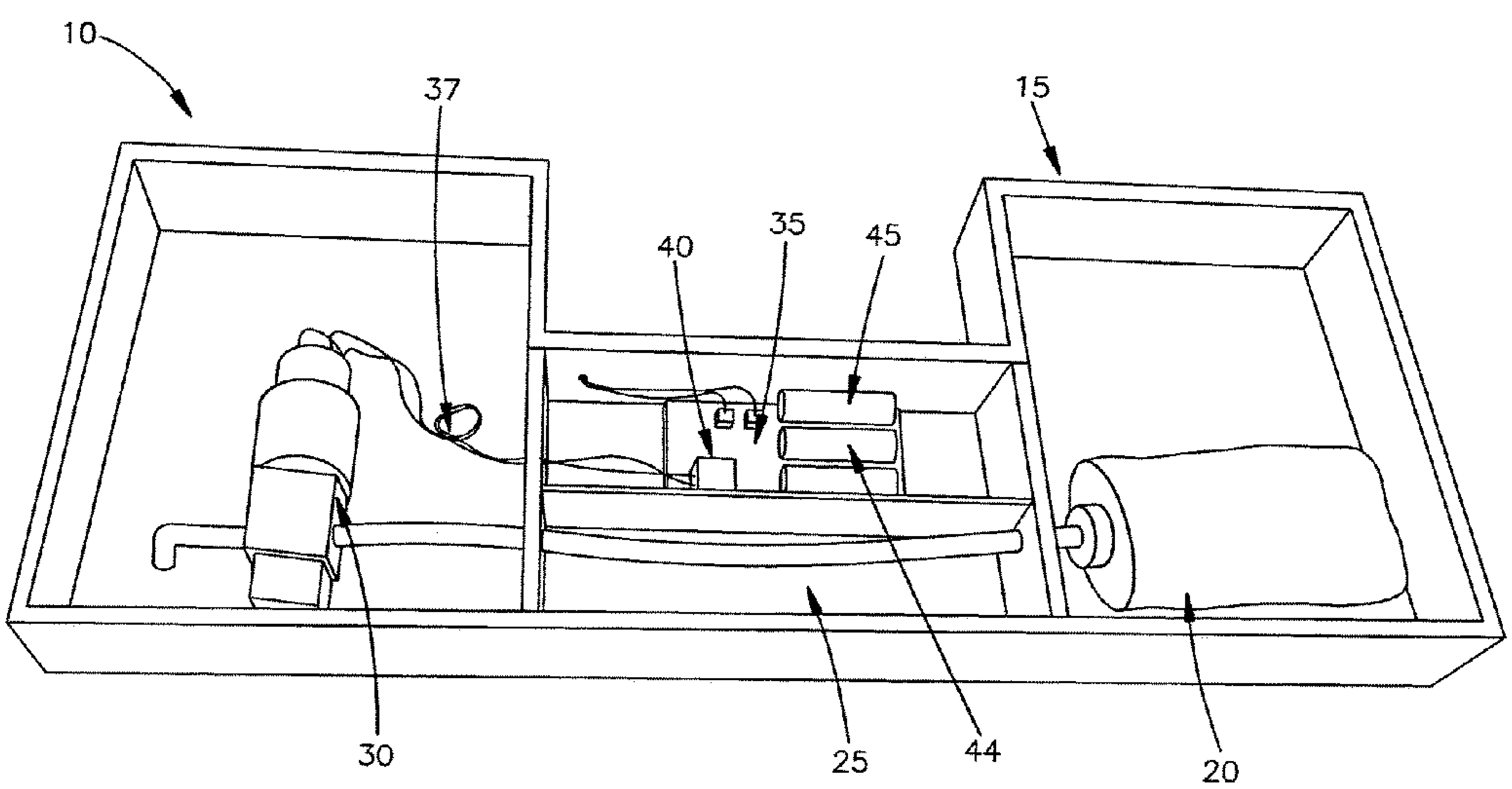
(57) **ABSTRACT**

An embodiment of the present invention includes an advanced adjustable density misting delivery system (AMDS) for detecting and neutralizing a fire. The AMDS includes a bladder containing a fire suppressant material, a pump operatively connected to the bladder via a tube, and a nozzle operatively connected to the pump and the bladder via the tube. The AMDS also includes a controller electrically connected to the pump and a sensor in communication with the controller, where the sensor is configured to detect a parameter that indicates the presence of the fire. The controller is configured to transition the pump from a deactivated state to an activated state when the sensor detects the parameter, such that in the deactivated state the pump does not operate, and in the activated state the pump causes the fire suppressant to flow from the bladder, through the tube, and out the nozzle.

18 Claims, 5 Drawing Sheets



(51) **Int. Cl.**
B05B 1/02 (2006.01)
B05B 3/08 (2006.01)

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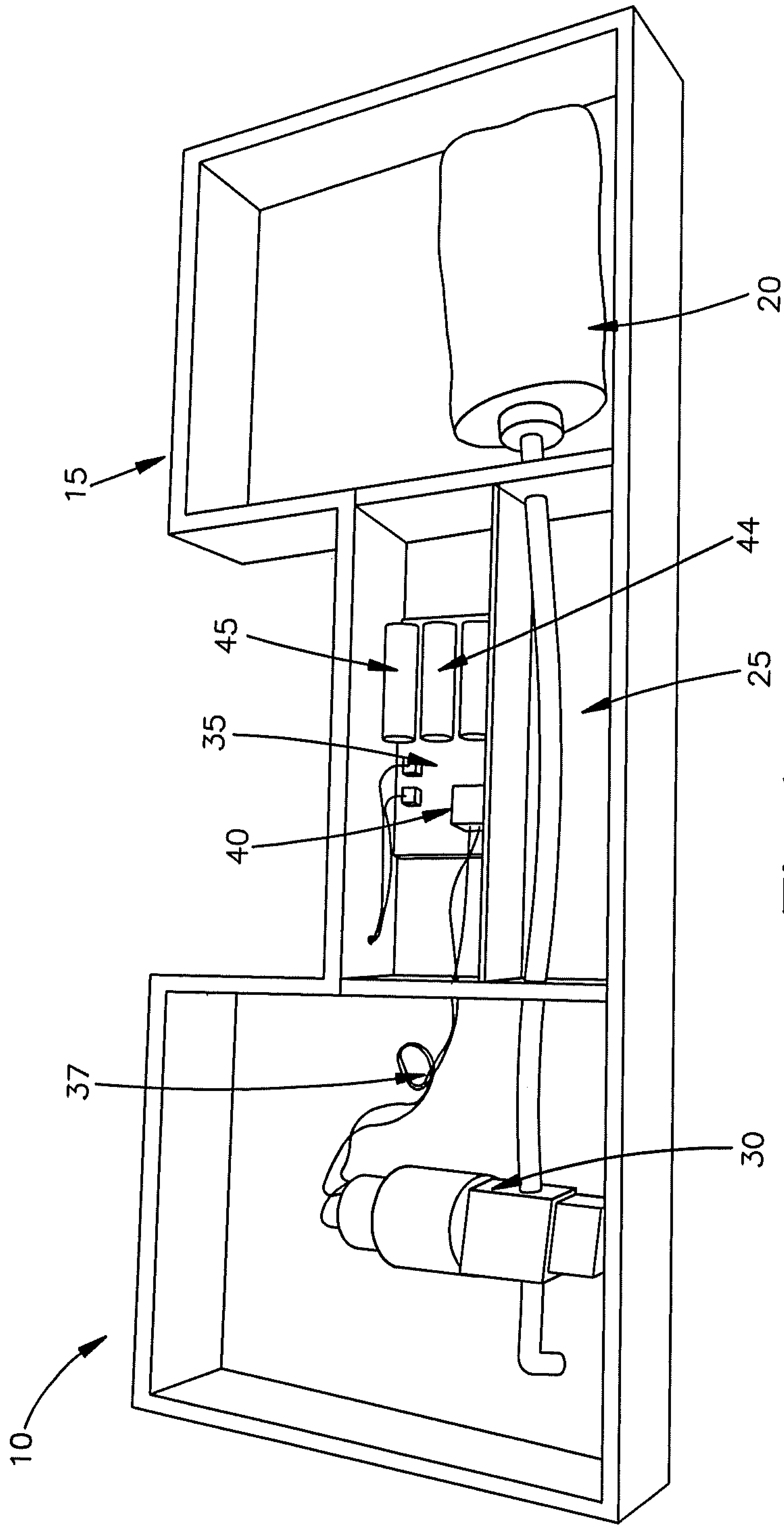


Fig. 1

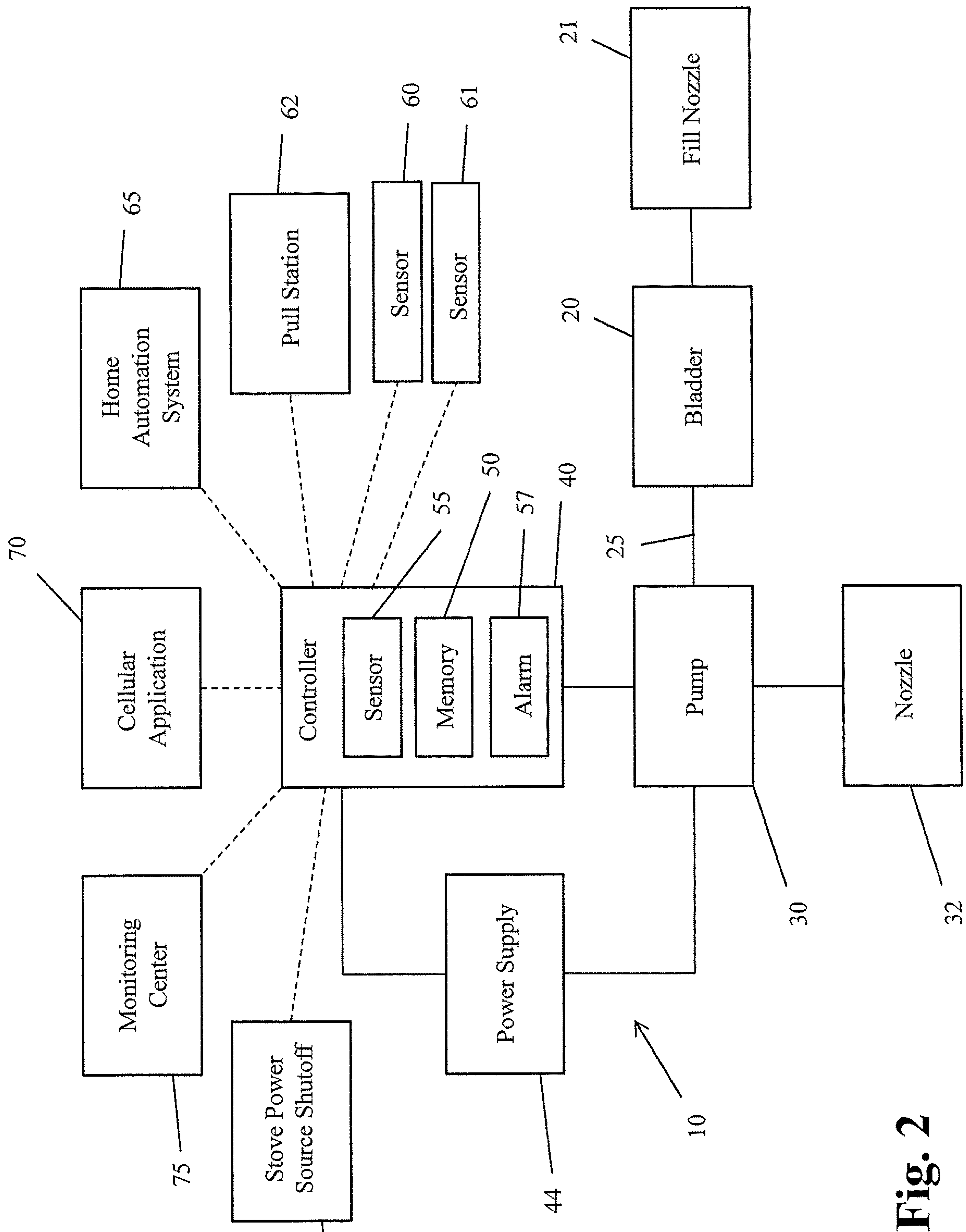
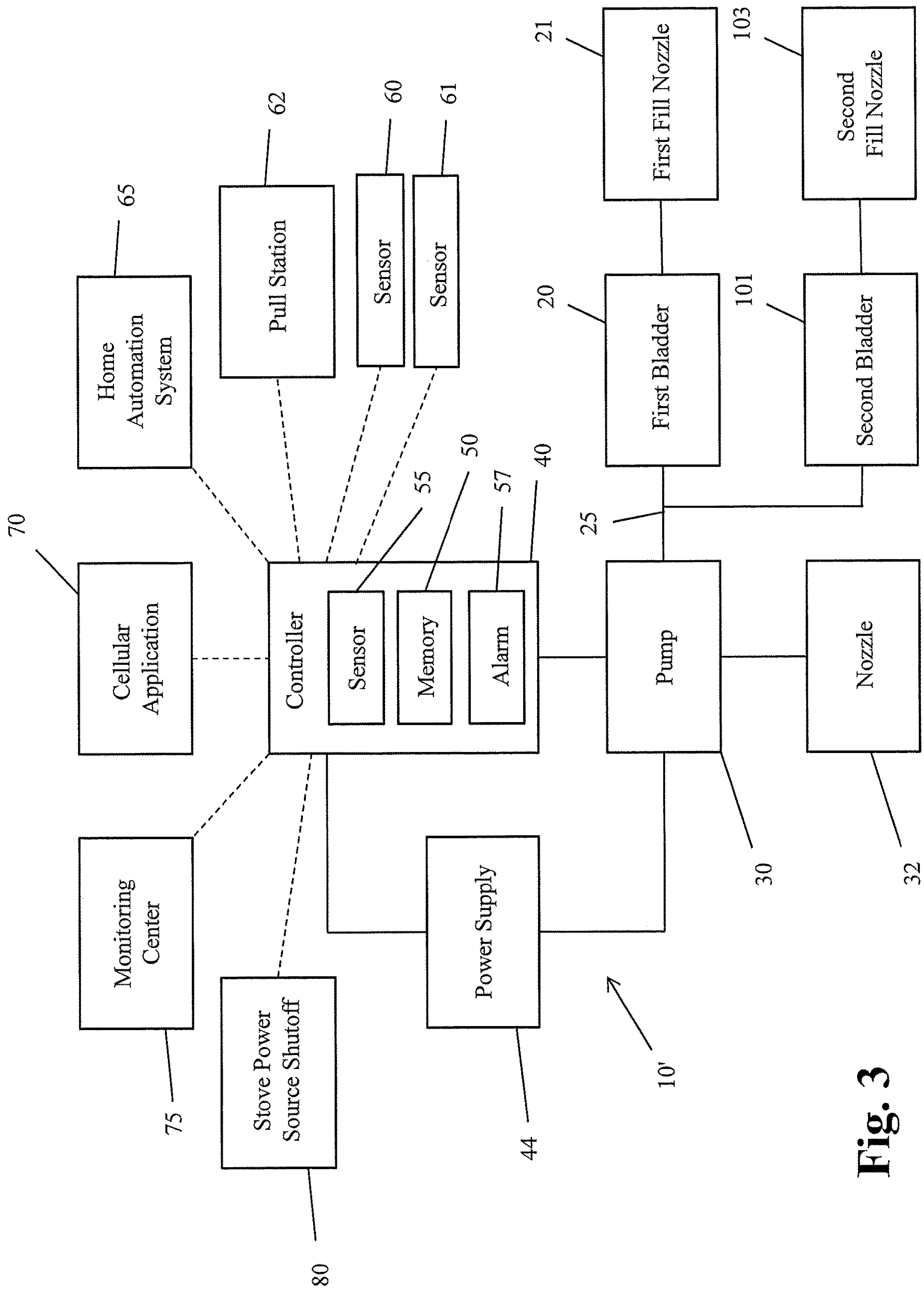

Home Automation System
65
Pull Station
62
Sensor
60
Sensor
61
Fill Nozzle
21
Bladder
20
25
Cellular Application
70
Controller
Sensor
55
Memory
50
Alarm
57
40
Pump
Nozzle
Monitoring Center
75
Stove Power Source Shutoff
80
Power Supply
44
30
32
10

Fig. 2



Home Automation System
65
Pull Station
62
Sensor
60
Sensor
61
First Fill Nozzle
21
Second Fill Nozzle
103
First Bladder
20
Second Bladder
101
Cellular Application
70
Controller
Sensor
Memory
Alarm
55
50
57
40
25
Pump
Nozzle
Monitoring Center
75
Stove Power Source Shutoff
80
Power Supply
44
30
32
10'

Fig. 3

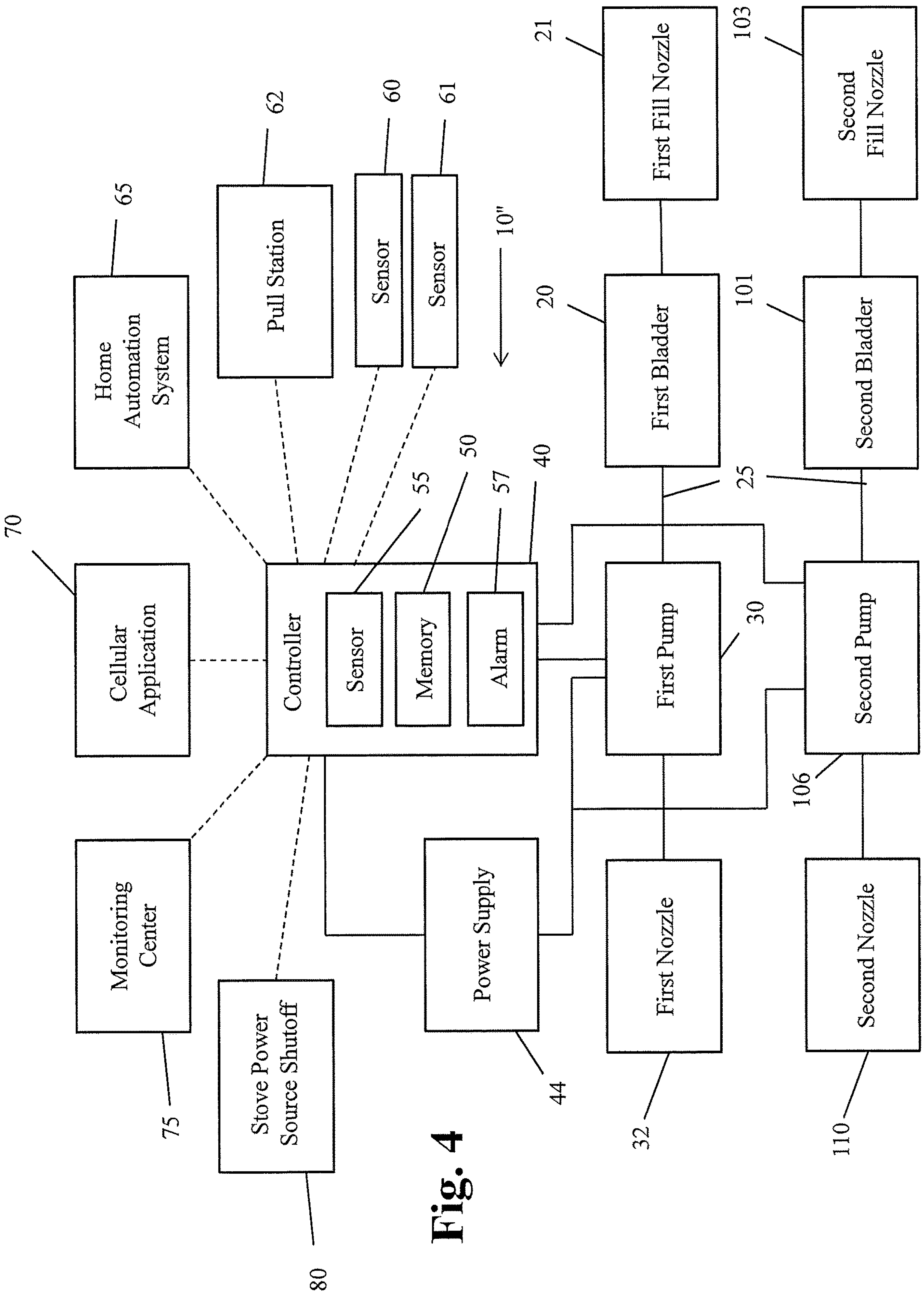
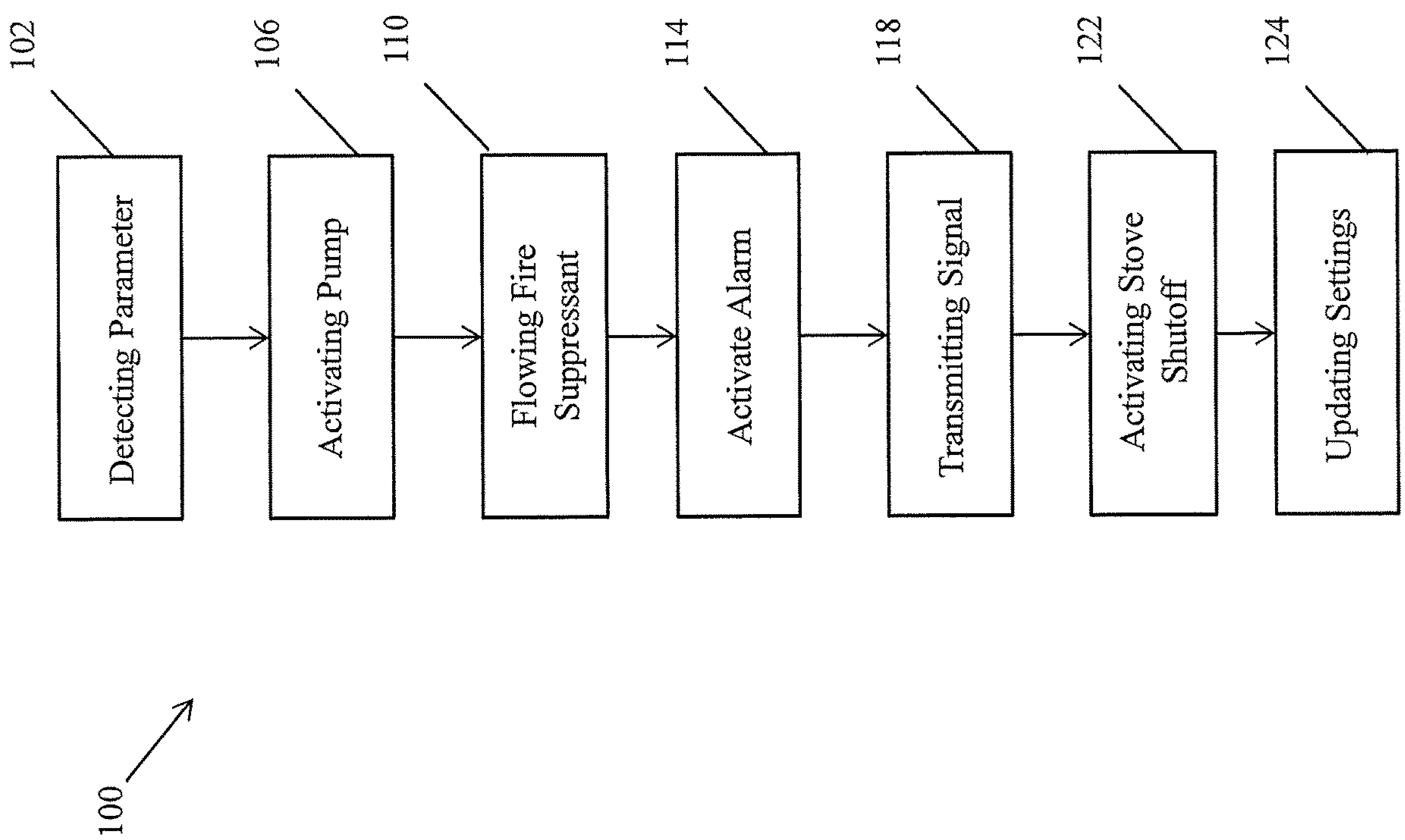

Home Automation System
Pull Station
Sensor
Sensor
First Fill Nozzle
Second Fill Nozzle
First Bladder
Second Bladder
Cellular Application
Controller
Sensor
Memory
Alarm
First Pump
Second Pump
Monitoring Center
Stove Power Source Shutoff
Power Supply
First Nozzle
Second Nozzle
65
62
60
61
21
103
10"
20
101
70
55
50
57
40
25
30
106
75
80
44
32
110

Fig. 4



102
Detecting Parameter
106
Activating Pump
110
Flowing Fire Suppressant
114
Activate Alarm
118
Transmitting Signal
122
Activating Stove Shutoff
124
Updating Settings
100

Fig. 5

ADVANCED MISTING DELIVERY SYSTEM, METHODS, AND MATERIALS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the priority benefit of U.S. Provisional Application No. 62/496,213, which was filed Oct. 11, 2016, as well as U.S. Provisional Application No. 62/492,756, which was filed May 1, 2017, each of which are incorporated herein by reference in their entireties.

TECHNICAL FIELD

The present invention relates to fire suppressant delivery systems. More particularly, this invention relates to misting systems for the delivery of a fire suppressant material to a fire.

BACKGROUND

Fires, especially those caused by flammable liquids, cause extensive amounts of property damage and human harm every year. In particular, a large proportion of fires start on electric or gas range stovetops. Currently, many systems exist for extinguishing fires, including handheld fire extinguishers and sprinkler systems. However, handheld fire extinguishers require manual actuation, while sprinkler systems cover a wide area, and can often destroy property during operation that extends well beyond the area affected by fire, and may not be suited for electrical or grease fires. Further, neither of these systems provide any methodology for helping determine the root cause of the fire after it has been extinguished. As a result, there is a need for a localized, automatic fire extinguishing system suited for stovetops, as well as a fire extinguishing system that includes forensic and auditing functionalities.

SUMMARY

An embodiment of the present invention includes an advanced adjustable density misting delivery system (AMDS) for detecting and neutralizing a fire. The AMDS includes a bladder containing a fire suppressant material, a pump operatively connected to the bladder via a tube, and a nozzle operatively connected to the pump and the bladder via the tube. The AMDS also includes a controller electrically connected to the pump and a sensor in communication with the controller, where the sensor is configured to detect a parameter that indicates the presence of the fire. The AMDS further includes a power supply configured to provide power to the controller and the pump. The controller is configured to transition the pump from a deactivated state to an activated state when the sensor detects the parameter, such that in the deactivated state the pump does not operate, and in the activated state the pump causes the fire suppressant to flow from the bladder, through the tube, and out the nozzle.

Another embodiment of the present invention includes an advanced adjustable density misting delivery system (AMDS) for detecting and neutralizing a fire. The AMDS includes a bladder containing a fire suppressant material and a pump operatively connected to the bladder via a tube. The AMDS also includes a nozzle operatively connected to the pump and the bladder via the tube, such that the pump is configured to cause the fire suppressant to flow from the bladder, through the tube, and out the nozzle. Additionally, the AMDS includes a controller electrically connected to the pump, where the controller includes a first sensor configured to detect a first parameter related to the operation of the AMDS. Further, the AMDS includes a second sensor in communication with the controller, the second sensor being configured to detect a second parameter that indicates the presence of the fire, and a power supply configured to provide power to the controller and the pump.

A further embodiment of the present invention includes a method for dispensing fire suppressant from an adjustable density misting delivery system (AMDS) that includes a hollow housing. The method includes detecting, via a sensor, a parameter that indicates the presence of a fire and activating, via a controller in communication with the sensor, a pump from a deactivated state to an activated state. The method also includes flowing the fire suppressant from a bladder, through tubes, and out a nozzle using force provided by the pump when the pump is in the activated state, wherein the bladder and tubes are disposed within the housing of the AMDS, and the nozzle is connected within the housing of the AMDS.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary, as well as the following detailed description, will be better understood when read in conjunction with the appended drawings. The drawings show illustrative embodiments of the invention. It should be understood, however, that the application is not limited to the precise arrangements and instrumentalities shown.

FIG. **1** is a top perspective view of an AMDS according to an embodiment of the present application;

FIG. **2** is a schematic view of an AMDS system including the AMDS shown in FIG. **1**;

FIG. **3** is a schematic view of an AMDS system according to another embodiment of the present application;

FIG. **4** is a schematic view of an AMDS system according to a further embodiment of the present application; and

FIG. **5** is a process flow diagram of a method according to an embodiment of the present application.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

While the invention is described herein using a limited number of embodiments, these specific embodiments are not intended to limit the scope of the invention as otherwise described and claimed herein. The precise arrangement of various elements and order of the steps of articles and methods described herein are not to be considered limiting. For instance, although the steps of the methods are described with reference to a sequential series of reference signs and progression of the blocks in the figures, the method can be implemented in any particular order as desired.

Embodiments of the present application include an adjustable density misting delivery system (AMDS) **10** for detecting and neutralizing a fire. Referring to FIGS. **1** and **2**, the AMDS **10** includes a housing **15** that is configured to contain various components of the AMDS **10**. The housing **15** can be comprised of any variety of metals, plastics, or other materials as desired, and can be manufactured through molding, casting, thermoforming, etc. The housing **15** is substantially hollow, such that it is capable of containing a variety of the components of the AMDS **10**. The housing **15** can also comprise a variety of shapes, such as rectangular, triangular, circular, etc. The shape of the housing **15** can be primarily determined by the intended mounting location of the AMDS

10, such that the housing can be configured to fit within a particular mounting location without being visually noticeable from an external position. For example, the housing **15** can be shaped to fit above a range hood of a conventional commercial or residential stovetop or within the range hood. Alternatively, the housing **15** can be mounted away from the stovetop, such as flush with a countertop adjacent to the stovetop or on a wall near the stovetop. The housing **15** can be mounted in any desired orientation, such as vertical or horizontal.

The AMDS **10** further includes features contained within and/or connected to the housing **15** that define a repository and flow path for fire suppressant material. The fire suppressant material can be a liquid, powder, or foam that is suitable for extinguishing a fire, particularly an oil or grease fire, where the use of water is not appropriate. This can be particularly useful in industrial, marine, municipal, oil, petrochemical, or transportation settings. In one example, the fire suppressant can be Pyrocool. Alternatively, the fire suppressant can be water. Further, the fire suppressant can be a class A foam, wetting agent, high expansion foam concentrate, or protein foam. However, the fire suppressant can be any type of fire suppressant as desired.

Continuing with FIGS. **1** and **2**, the AMDS **10** includes a bladder **20** within the housing **15** that contains a fire suppressant material. The bladder **20** can comprise a pouch or bag made from a flexible moisture-impermeable material that is capable of housing the fire suppressant material indefinitely. For example, the bladder **20** can be formed from a polymer. The bladder **20** can be sized depending on the particular AMDS **10** it will be used in, as well as the intended installation setting of that AMDS **10**. For example, the bladder **20** can contain between 16 and 48 ounces of a fire suppressant material. However, the bladder **20** can be sized to contain more or less fire suppressant material as desired. The bladder **20** can be non-pressurized, and can be either single-use or refillable. Further, the bladder **20** can comprise any plastic or other polymer as desired.

In embodiments where the bladder **20** is refillable, the AMDS **10** can include a fill nozzle **21** operatively connected to the bladder **20**. The fill nozzle **21** can be integral with the housing **15**, or the fill nozzle **21** can be exterior to the housing **15**. In one embodiment, the fill nozzle **21** defines a portal (not shown) in fluid communication with the bladder **20**, and a threaded cap (not shown) releasably securable to the portal. The fill nozzle **21** allows an owner or servicer of the AMDS **10** to refill the bladder **10** with fire suppressant material from an external supply (not shown) without dismantling the housing **15** and replacing the bladder **20**. This allows a user of the AMDS **10** to ensure that the bladder **20** is sufficiently full at all times to extinguish a potential fire, and reduce waste by reuse of an existing bladder **20**. In fire suppressant systems without refillable bladders, a suppressant storage device may need to be discarded before it is fully depleted because the remaining amount of fire suppressant is insufficient to extinguish a fire. This results in wasted fire suppressant, which increases costs associated with operating a fire suppressant system. Alternatively, the fill nozzle **21** allows an owner or servicer of the AMDS **10** to pump fire suppressant out of the bladder **20**. This allows for easy replacement of fire suppressant when a different type of fire suppressant is desired, or the existing fire suppressant is deemed too dated.

The AMDS **10** further includes a pump **30** disposed within the housing **15**, where the pump **30** is operatively connected to the bladder **20** through tubes **25**. The pump **30** is configured to flow the fire suppressant material from the bladder **20** and through the tubes **25**. The pump **30** can be any type of electric pump capable of actuating the flow of fire suppressant. For example, the pump **30** can be a gear pump, screw pump, progressing cavity pump, roots-type pump, plunger pump, triplex-style plunger pump, compressed air powered double-diaphragm pump, rope pump, impulse pump, hydraulic ram pump, radial flow pump, axial flow pump, mixed flow pump, educator jet pump, or gravity pump. The pump **30** can be capable of creating a pressure within the tubes **25** of between about 50 psi to about 100 psi (about 3.4 bar to about 6.9 bar). The pump **30** can also be capable of creating a flow rate of fire suppressant through the tubes **25** of about 4.0 cubic meters per minute. However, none of these ranges are meant to be construed as limiting, as the use of pumps capable of pressure and flow rates beyond the enumerated ranges is contemplated.

The tubes **25** are preferably comprised of a chemical and/or fire resistant material. Further, the tubes **25** can be flexible. Specifically, the tubes **25** can be comprised of metal or a flexible polymer. The tubes **25** can include one tube, or can include any number of tubes as desired. The fittings of the tubes **25** can be secured with shrink tubes (not shown), and portions of the tubes **25** can be connected via quick connect fittings (not shown). In addition to connecting the pump **30** to the bladder **20**, the tubes **25** can connect the pump **30** and bladder **20** to a nozzle **32**. The nozzle **32** can be integral with the housing **15**. Alternatively, the nozzle **32** is releasably attached to the housing **15**, such as through a threaded engagement. This allows the nozzle **32** to be easily replaced. The nozzle **32** can also include a barbed fitting that is configured to engage either the housing **15** or the tubes **25**, such that the nozzle **32** is easily attachable to the AMDS **10**. The nozzle **32** can define a variety of spray patterns, where each particular spray pattern is determined based upon the particular environment in which the AMDS **10** is installed, as well as the intended spray area and pattern of the fire suppressant. In one embodiment, the nozzle **32** defines a plurality of outlet holes (not shown), each of which can define a diameter that is between 0.05 mm to about 0.30 mm. Alternatively, the nozzle **32** can define a single outlet (not shown). The outlet of the nozzle **32** can be defined such that the fire suppressant material exits as particles and/or droplets with as small a diameter as possible, while still being large enough to be unaffected by heat rise and/or wind during a dispensing operation, which will be described further below. The nozzle **32** can further be configured such that the outlet can be manually adjustable by a user, such that the user can alter the outlet to suit a specific environment that the AMDS **10** is installed in.

The AMDS **10** further includes a power supply **44** that powers the pump **30**. The power supply **44** can be disposed internally within the housing **15**, or the power supply **44** can be spaced from the housing **15**. As shown in FIG. **1**, the power supply can include one or more batteries **45**. However, the power supply **44** can also include a wired connection to an external power source, such as an electrical outlet. In one embodiment, the power supply **44** of the AMDS **10** can include both of one or more batteries **45** and a wired connection to an external power supply as a redundancy, such that the AMDS **10** continues to receive power during a power outage or in the event the charge of the batteries **45** becomes depleted. The power supply **44** can also power a controller **40** connected to a circuit board **35**, where the controller **40** is electrically connected to and controls operation of the pump **30**. The controller **40** can be connected to the pump **30** and the power supply **44** through wires **37**.

The AMDS **10** also includes a sensor **60** in electronic communication with the controller **40**. The sensor **60** notifies the controller **40** when a parameter that indicates the presence of a fire has been encountered, and can be in wired (such as through electrical wire or fiber optic cable) or wireless communication with the controller **40**. For example, the sensor **60** can be a temperature sensor or a humidity sensor. However, the sensor **60** can be capable of measuring any different physical, chemical, or other environmental attributes that can be indicative of the presence of a fire, as well as differentiate between parameters indicative of a fire and those caused by a normal cooking process. The sensor **60** can be either active or passive. In one embodiment, the sensor **60** is an adjustable temperature probe or a fixed temperature sensor, and the sensor **60** notifies the controller **40** when the sensor **60** detects a temperature that surpasses a predetermined threshold. The predetermined temperature threshold can be between about 135 degrees Fahrenheit and 250 degrees Fahrenheit. In another embodiment, the sensor **60** notifies the controller **40** when the rate of increase of temperature surpasses a predetermined threshold. Alternatively, the threshold can be a humidity threshold. In a further embodiment, the sensor **60** can be a camera, such that the sensor **60** notifies the controller **40** when the sensor **60** detects a visual or infrared pattern indicative of a fire. Additionally, the sensor **60** can be capable of utilizing radar, infrared pulsing, sonar, laser, or other range detection methods to detect the amount and concentration of objects on a stovetop. The sensor **60** can be an audial sensor that detects sound patterns that are indicative of the presence of a fire, or third-part smoke or fire alarm that has activated in response to a fire. The controller **40** can continuously analyze the information received from the sensor **60**, and determine when the parameter sensed by the sensor **60** indicates the presence of a fire. In another embodiment, the sensor **60** can comprise a spring-loaded, fusible link that melts in response to exposure to a predetermined temperature. As such, the sensor **60** can be single-use.

The AMDS **10** can include more than one sensor, such as two sensors—shown as sensors **60** and **61** in FIG. **2**—for redundancy. When the AMDS **10** includes more than one sensor, the sensors **60** and **61** can each be of the same or different types, which can be selected from any of the sensor types enumerated above. The controller **40** can direct the pump **30** to activate when either of the sensors **60** or **61** detects a parameter indicative of the presence of a fire, or only when both of the sensors **60** or **61** detect a parameter indicative of the presence of a fire. The controller **40** can be configured to receive a user input that alters the threshold parameters in which the controller **40** will determine that a signal received from the sensor **60** or sensor **61** indicates the presence of a fire. This user input can be received from a home automation system **65**, a cellular application **70**, or a monitoring center **75**, which will each be discussed further below, and can involve a keypad, touchscreen, voice commands, etc. For example, when the sensors **60** and/or **61** are temperature sensors, a user can provide an input to the controller **40** that lowers the temperature at which the controller **40** will determine that a fire is present to about 135 degrees Fahrenheit. Alternatively, a user can provide an input to the controller **40** that raises the temperature at which the controller **40** will determine that a fire is present to about 250 degrees Fahrenheit.

As indicated by the dashed lines in FIG. **2**, the controller **40** can be in communication with aspects of the AMDS **10**, in particular the sensor **60**, wirelessly. For example, the controller **40** can receive from or transmit a signal to the sensor **60** via ZigBee, Z-wave, Bluetooh, Wi-Fi, or radio wave. In particular, the radio wave can be a 319.5 MHz radio wave. Additionally, 802.11 standards or 802.15 standards can be used. These methods of wireless connection are equally applicable to other components wirelessly connected to the controller **40**, as described below. Such wireless connections allow the sensor **60** to be spaced from the housing **15**, such that the sensor **60** can be positioned in a location that can provide the earliest indication that a fire has started. However, it is also contemplated that the sensor **60** can be connected to the controller **40** through wires. The controller **40** can also include an alarm **57** that is configured to transition from an inactive state to an active state when the controller determines that a fire has been sensed. For example, the alarm **57** can include a piezo device, a siren, and/or an LED light. In addition to indicating that a fire has been sensed, the alarm **57** can produce a certain notification that alerts the operator of a low charge of battery **45** or need for servicing of the AMDS **10**, either upon sensing a particular issue or at a predetermined time interval.

The controller **40** can also include a memory unit **50** and a sensor **55**. The memory unit **50** and sensor **55** provide the controller **40** with forensic and auditing functionalities. This functionality allows the AMDS **10** to record and store information in the memory unit **50** related to the operation of the AMDS **10**, including static information related to component parts, operational statistics, and external factors (such as parameters that indicate the presence of a fire) that affect operation of the AMDS **10**. The memory unit **50** can be volatile (such as some types of RAM), non-volatile (such as ROM, flash memory, etc.), or a combination thereof. Further, the memory unit **50** can include tape, flash memory, smart cards, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, universal serial bus (USB) compatible memory, or any other medium which can be used to store information and which can be accessed by a user or operator of the AMDS **10**. The memory unit **50** can be configured to store parameters detected by the sensor **50**, as well as parameters detected by the sensor **60**, over a period of time. Though the memory unit **50** is depicted as integral with the controller **40**, the memory unit **50** can be spaced from the controller **40**. For example, the memory unit **50** can be located at a monitoring center **75** or home automation system **65** (described further below). However, the memory unit **50** can be located at any remote database as desired.

In one embodiment, during the course of operating the AMDS **10**, the sensor **55** can be configured to detect a parameter related to the certain aspects of the operation of the AMDS **10** and its component parts, such as time of activation of the pump **30**, duration of operation of the pump **30**, speed at which the pump **30** flows the fire suppressant, amount of fire suppressant flowed by the pump **30**, reason for activation of the pump **30**, and torque of the pump **30**. As such, the sensor **55** can be a clock or timer, flow meter, volumetric flow meter, or torque meter. Though the sensor **55** is depicted as integral with the controller **40**, the sensor **55** can be spaced from the controller **40**. For example, the sensor **55** can be in communication with the pump **30**, the tubes **25**, or the bladder **20**. Alternatively, the sensor **55** can be spaced some distance exterior to the housing **15**. As such, the sensor **55** can be in either wired (such as through electrical wire or fiber optic cable) or wireless communication with the controller **40** when it is spaced from the housing **15**. When the sensor **55** is in wireless communication with the controller **40**, the wireless communication can be performed using via ZigBee, Z-wave, Bluetooth, Wi-Fi, or radio waves.

In addition to the information sensed by the sensor **55**, the memory unit **50** can be preprogrammed with information related to the component parts of the AMDS **10**. This information can include parameters of the nozzle **32**, parameters of the motor **30**, parameters of the bladder **20**, serial numbers, part numbers, part tolerances, etc. This information can be programmed into the memory **50** upon manufacturing of the AMDS **10**, by an installer of the AMDS **10**, or by the end user of the AMDS **10**. As a result, the information related to the component parts of the AMDS **10** stored by the memory unit **50** can be altered or overwritten when parts of the AMDS **10** are removed or replaced.

The memory unit **50** can further function to record information collected by the sensor **60** and/or sensor **61**. This information can include temperature changes, rate of temperature change, vapor content, chemical composition, audio signal, or visual images. This information can be recorded on a continuous basis, and the memory unit **50** overwritten at predetermined intervals if no fire has been detected. Alternatively, the memory unit **50** can initiate recording data collected by the sensor **60** upon the controller's determination that a fire has been detected. This data, along any data stored that relates to components of the AMDS **10** or was collected by the sensor **55**, can be useful for a variety of reasons. After the AMDS **10** has been activated and fire suppressant has been dispensed, retrospective analysis of the information stored in the memory unit **50** can help an owner of the building or business the AMDS **10** is installed in determine the cause of a fire. Alternatively, the information stored by the memory unit **50** can be later accessed and analyzed by an insurance company, emergency responder, or other regulatory agency to determine the cause of a fire and resulting liability. Additionally, the AMDS **10** manufacturer can collect information stored by the memory unit **50** to evaluate the performance of the AMDS **10** and further optimize the design and operation of the AMDS **10**.

In addition to the components already listed, the controller **40** can also be in electronic communication with a variety of other components. In one embodiment, as shown in FIG. **2**, the AMDS **10** can include a manual pull station **62** in communication with the controller **40** for manually transitioning the pump **30** between an activated state and a deactivated state. In one embodiment, the pull station **62** can take the form of a physical lever, switch, button, or similar device physically attached to the housing **15** that is in electrical communication with the controller **40**. Upon actuation of the pull station **62**, the pull station **62** can direct the controller **40** to either transition the pump **30** from a deactivated state to an activated state, or from an activated state to a deactivated state. Manual actuation of the pump **30** allows a user to deactivate the pump **30** if the user of the AMDS **10** sees that a fire has been extinguished, or manually activate the pump **30** if the user detects a fire that has not been detected by the sensor **60**. The addition of a pull station **62** also enables the AMDS **10** to comply with the UL 300 Standard, which relates to fire testing of fire extinguishing systems for the protection of commercial cooking equipment. Compliance with UL 300 standards can be mandatory for commercial kitchens in many localities.

However, in another embodiment, the pull station **62** can be spaced from the housing **15**. In this embodiment, the pull station **62** can still comprise a physical lever, switch, button or similar device, but can be isolated from the housing **15**. For example, the pull station **62** can be disposed on a wall near a stovetop, in a cupboard, adjacent to a light switch, under a countertop, or any other location as desired by an operator of the AMDS **10**. Additionally, the pull station **62** can be electronically connected to the controller **40** either through a wired or wireless connection. Like the sensor **60** indicated above, the wireless communication between the controller **40** and the pull station **62** can be performed via ZigBee, Z-wave, Bluetooth, Wi-Fi, or radio waves. Even though the pull station **62** is depicted as separate from other components of the AMDS **10**, the pull station **62** can be designed as an integral feature of another aspect of the AMDS **10**. For example, the pull station **62** can be included in a home automation system **65**, cellular application **70**, or monitoring center **75** (each of which will be described further below). As such, the pull station **62** can take the form of a digital feature of any of the aforementioned components rather than a physical switch or button.

Continuing with FIG. **2**, the AMDS **10** can further be in communication with a home automation system **65**. The home automation system **65** can be any conventional type of home automation system, and can be configured to control and monitor various other residential or business features in addition to the AMDS **10**, such as lights, entry alarms, thermostats, locks, etc. The AMDS **10** can be integrated with the home automation system **65** either through wires or wirelessly, which allows a user to control or monitor the AMDS **10** through a hub or other user input of the home automation system **65**. When wirelessly connected, the wireless communication between the home automation system **65** and the AMDS **10**, particularly the controller **40**, can be performed via ZigBee, Z-wave, Bluetooth, Wi-Fi, or radio waves. For example, a user can use the home automation system **65** to monitor such information related to the AMDS **10** as the status of the power supply **44**, amount of fire suppressant in the bladder **20**, parameters sensed by the sensor **60** and/or **61**, and mode (active or inactive) of the pump **30**. Additionally, a user can update settings of the AMDS **10** through a user input of the home automation system **65**, such as the predetermined threshold for a parameter that indicates the presence of a fire or the mode of operation of the pump **30**.

Like the home automation system **65**, the AMDS **10** can also be in communication with a cellular application **70**. The cellular application **70** can be specifically suited for cellular devices, or can be configured to operate on any type of electronic device, such as a tablet, laptop, PC, etc. The cellular application **70** can also be specifically designed to monitor the AMDS **10**, or can be a third party application configured to integrate with the AMDS **10**. Connection to the AMDS **10** with a cellular application **70** also allows multiple users to monitor and/or control the AMDS **10** at once. Connection to a cellular application **70** can be done through any form of wireless communication, such as via ZigBee, Z-wave, Bluetooth, Wi-Fi, or radio waves. Like the home automation system **65**, a user can use the cellular application **70** to monitor information related to the AMDs **10** and/or update settings of the AMDs **10** through the user interface (not shown) of the cellular application **70**.

Further, the AMDS **10** can be in communication with a monitoring center **75**. The monitoring center **75** can be a third party service that monitors a plurality of AMDS **10** across many locations, or can be the dispatch center for first responders. Like the home automation system **65** and the cellular application **70**, the connection between the AMDS **10** and the monitoring center **75** can be wireless, and can be performed using via ZigBee, Z-wave, Bluetooth, Wi-Fi, or radio waves. Alternatively, the connection can be wired through conventional electrical wires or fiber optic cable. When the monitoring center **75** receives a signal from the controller **40** that the sensor **60** has detected a parameter that the controller **40** determines indicates the presence of a fire, the monitoring center **75** can contact the owner of the AMDS **10**, as well as notify the nearest fire department in order to dispatch first responders to the location of the AMDS **10**. Optionally, if the owner notifies the monitoring center **75** that the notification was a false alarm, the monitoring center **75** may not contact the fire department.

Continuing with FIG. **2**, the AMDS **10** can also include a stove power source shutoff **80** that is in electrical or fluid communication with the power source of a residential or commercial stove. The stove power source shutoff **80** can comprise a valve, switch, or other means for cutting off power to a stove when the controller **40** determines that the sensor **60** has detected a parameter indicative of a fire. As such, the stove power source shutoff **80** can be utilized with both electric and gas-powered ranges. In addition to dispensing fire suppressant from the nozzle **32**, this functionality allows the AMDS **10** to ensure that the initial cause of the fire, whether it is burnt food or grease, is not provided more fuel. In one embodiment, the controller **40** automatically activates the stove power source shutoff **80** when the controller **40** determines that the sensor **60** has detected a parameter indicative of a fire. Additionally, the AMDS **10** can allow a remote user to manually activate the stove power source shutoff **80** remotely, which can be performed using the pull station **62**, home automation system **65**, cellular application **70**, monitoring center **75**, or through a user input (not shown) on the housing **15** of the AMDS **10** itself.

Referring to FIG. **3**, an AMDS **10'** according to an alternative embodiment will be described. The AMDS **10'** shares many similar features with AMDS **10**, and as such identical reference numbers will be used. However, in AMDS **10'**, the bladder **20** is a first bladder and the nozzle **21** is a first fill nozzle. As such, the AMDS **10'** includes a second bladder **101** and a second fill nozzle **103** in fluid communication with the pump **30** and nozzle **32** through tubes **25**. The addition of a second bladder **101** and second fill nozzle **103** serves several purposes. In one aspect, certain environments or potential fire sources can require a mix of different fire suppressants to adequately address. However, certain fire suppressants may not be able to be mixed until the moment of application to the fire source. As such, the first bladder **20** can contain a first fire suppressant material, while the second bladder **101** contains a second fire suppressant material. The addition of a second bladder **101** and second fill nozzle **103** addresses this functionality by providing a user of the AMDS **10'** a second repository for storing fire suppressant that is separate from the first bladder **20**. Alternatively, the second bladder **101** and second fill nozzle **103** can serve as a redundancy for the first bladder **20** and first fill nozzle **32**. In the event that the bladder **20** becomes obstructed for some reason or becomes fully depleted, the pump **30** will still be able to draw fire suppressant material from the second bladder **101**.

Referring to FIG. **4**, an AMDS **10"** according to another alternative embodiment will be described. The AMDS **10"** shares many similar features with the AMDS **10** and AMDS **10'**, and as such identical reference numbers will be used. Like the AMDS **10'**, the AMDS **10"** includes first and second fill nozzles **21** and **103**, as well as first and second bladders **20** and **101**. However, in the AMDS **10"**, the pump **30** is a first pump and the nozzle **32** is a first nozzle **32**, and the AMDS **10"** further includes a second pump **106** and a second nozzle **110**. As such, the AMDS **10"** can include two completely separate flow paths, with one flow path comprising the first fill nozzle **21**, first bladder **20**, first pump **30**, and first nozzle **32**, while the second flow path includes the second fill nozzle **103**, second bladder **101**, second pump **106**, and the second nozzle **110**. Like the first pump **30**, the second pump **106** can receive power from the power supply **44** and be controlled by the controller **40**. As with the second fill nozzle **103** and the second bladder **101**, the inclusion of the second pump **106** and the second nozzle **110** provides redundancy to the AMDS **10"**, such that if something happens to the first pump **30** and first nozzle **32**, such as the first pump **30** becoming nonoperational or the first nozzle **32** becoming clogged, the AMDS **10"** has a completely separate flow path that can serve as a backup. Further, in some embodiments, the inclusion of the second pump **106** and the second nozzle **110** provides the opportunity to provide a second source of fire suppressant material that is different than or duplicative of the first fire suppressant material.

Referring to FIG. **5**, operation of the AMDS **10** according to method **100** will be described. Though described specifically in relation to the AMDS **10**, method **100** may similarly be employed with AMDS **10'** and AMDS **10"**. At the beginning of method **100**, the AMDS **10**, and particularly the pump **30**, will be in an initial deactivated state. In this deactivated state, the pump **30** is not operating and thus no fire suppressant is flowing through the tubes **25** and out the nozzle **32**. However, as shown in step **102** of method **100**, at a certain time the sensor **60** (an/or sensor **61**) can detect a parameter that the controller **40**, based upon predetermined thresholds, determines indicates the presence of a fire. At this time, in step **106**, the controller **106** activates the pump **30** from the initial deactivated state to an activated state when the sensor **60** (and/or sensor **61**) detects the parameter. When the pump is in the activated state, step **110** is performed, which involves the pump **30** flowing fire suppressant from the bladder **20**, through the tubes **25**, and out of the nozzle **32**.

The flowing step **110** can take several different embodiments, primarily based upon the mode that the pump **30** is operating in. In one embodiment, step **110** includes continuously flowing fire suppressant through the tubes **25** and out the nozzle **32** for a period of time. Though this can be the quickest method of putting out a fire, it can also exhaust the supply of fire suppressant the quickest. As such, other embodiments of step **110** are contemplated. For example, in another embodiment, step **110** involves intermittently flowing fire suppressant out of the bladder **20**, such that the fire suppressant flows for a period of time, stops flowing out of the nozzle **32** for a second period of time that is after the first period of time, and resumes flowing the first suppressant from the bladder **20**, through the tubes **25**, and out the nozzle **32** for a third period of time that is after the second period of time. Subsequent periods of stopping and starting flow are also possible. This embodiment can function to help conserve fire suppressant by increasing the time period before the bladder **20** becomes depleted. For example, the first, second, and third period of times can be 30 seconds. However, the first, second, and third periods of time can be other increments of time as desired. Step **110** can also include a special dispensing operation, in which a marker or special fluid flows through tubes **25** and out of nozzle **32** in addition to or in place of the fire suppressant material for forensic purposes. Further, step **110** can comprise a preventative dispensing operation, in which the fire suppressant does not flow out of the nozzle **32** directly onto a fire, but rather flows out of the nozzle **32** to a periphery of the fire, such that the AMDS **10** prevents the fire from spreading.

The method **100** can further include step **114**, which involves activating an alarm **57** upon the controller **40** determining that the sensor **60** has detected a parameter indicative of the presence of a fire. As noted above, the alarm **57** can include a piezo device, a siren, and/or an LED light. Additionally, the method **100** can include step **114**, which involves transmitting a signal from the controller **40** to a monitoring center that indicates that the sensor **60** detected the parameter than the controller **40** determines indicates a fire's presence. While the term "monitoring center" is used, step **114** can include transmitting the signal that indicates that the sensor **60** detected the parameter than the controller **40** determines indicates a fire's presence to the home automation system **65**, the cellular application **70**, and/or the monitoring center **75**. In other embodiments, the signal can indicate a variety of other statuses related to the AMDS **10**, including a low charge of the battery **45**, low level of fire suppressant material, need for servicing, etc. Method **100** can further include step **122**, which includes activating the stove power source shutoff **80** in response to the sensor **60** detecting the parameter than the controller **40** determines indicates the presence of a fire. As noted above, the stove power source shutoff **80** can comprise a valve, switch, or other means for cutting off power to a stove that is usable with both electric and gas-powered ranges. This ensures that the initial cause of the fire, whether it is burnt food or grease, is not provided more fuel. Additionally, method **100** can include step **144**, which involves transmitting a signal from a user input to the controller **40** that updates a setting of the AMDS **10**. This user input can be located at the monitoring center **75**, the cellular application **70**, or the home automation system **65**. In one embodiment, the setting that can be updated is the threshold for the parameter detected by the sensor **60** (for example, the temperature threshold), where the threshold is the limit beyond which the controller **40** determines that a fire is present. Though steps **110-124** are shown sequentially in a particular order in FIG. **5**, each of steps **110-124** can be performed interchangeably in other orders as desired.

The present disclosure is described herein using a limited number of embodiments. These specific embodiments are not intended to limit the scope of the disclosure as otherwise described and claimed herein. Modification and variations from the described embodiments exist. More specifically, the examples included are given as a specific illustration of embodiments of the claimed disclosure. It should be understood that the invention is not limited to the specific details set forth in the examples, and that various changes, substitutions, and alterations can be made without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed:

1. An advanced adjustable density misting delivery system (AMDS) for detecting and neutralizing a fire, the AMDS comprising:

a bladder containing a fire suppressant material;

a pump operatively connected to the bladder via a tube;

a nozzle operatively connected to the pump and the bladder via the tube;

a controller electrically connected to the pump;

a sensor in communication with the controller, the sensor being configured to detect a parameter that indicates the presence of the fire; and

a power supply configured to provide power to the controller and the pump,

wherein the controller is configured to transition the pump from a deactivated state to an activated state when the sensor detects the parameter, such that in the deactivated state the pump does not operate, and in the activated state the pump pumps the fire suppressant from the bladder, through the tube at a pressure of between about 50 psi and about 100 psi, and out the nozzle.

2. The AMDS of claim **1**, wherein the controller includes an alarm that is configured to transition from an inactive state to an active state when the sensor detects the parameter.

3. The AMDS of claim **2**, wherein the alarm is a piezo device, an LED light, or a siren.

4. The AMDS of claim **1**, wherein the power supply comprises one or more batteries, a wired connection to an external power supply, or the one or more batteries and the wired connection to the external power supply.

5. The AMDS of claim **1**, further comprising a fill nozzle operatively connected to the bladder, wherein the fire suppressant material can be disposed from an external supply through the fill nozzle to refill the bladder.

6. The AMDS of claim **1**, wherein the bladder is a first bladder and the fire suppressant material is a first fire suppressant material, and the AMDS further comprises a second bladder that contains a second fire suppressant material.

7. The AMDS of claim **1**, wherein the bladder is non-pressurized.

8. The AMDS of claim **1**, wherein the parameter is a humidity threshold, a temperature threshold, a sound pattern, a temperature increase rate threshold, a visual pattern, or an infrared pattern.

9. The AMDS of claim **1**, wherein the sensor is in communication with the controller through a wireless connection.

10. The AMDS of claim **9**, wherein the sensor is configured to transmit a signal to the controller that indicates detection of the parameter through the wireless connection via ZigBee, Z-wave, or radio wave.

11. The AMDS of claim **1**, wherein the sensor is a first sensor and the parameter is a first parameter, and the controller includes a memory unit and a second sensor configured to detect a second parameter related to the operation of the AMDS.

12. The AMDS of claim **1**, wherein the sensor is a first sensor, the AMDS further comprising a second sensor configured to detect the parameter that indicates the presence of the fire, wherein the controller is configured to transition the pump from a deactivated state to an activated state when both the first and second sensors detect the parameter.

13. An advanced adjustable density misting delivery system (AMDS) for detecting and neutralizing a fire, the AMDS comprising:

a bladder containing a fire suppressant material;

a pump operatively connected to the bladder via a tube;

a nozzle operatively connected to the pump and the bladder via the tube, wherein the pump is configured to pump the fire suppressant from the bladder, through the tube at a pressure of between about 50 psi and about 100 psi, and out the nozzle;

a controller electrically connected to the pump, wherein the controller includes a first sensor configured to detect a first parameter related to the operation of the AMDS;

a second sensor in communication with the controller, the second sensor being configured to detect a second parameter that indicates the presence of the fire; and a power supply configured to provide power to the controller and the pump.

14. The AMDS of claim **13**, wherein the first parameter includes a duration of operation of the pump, a speed at which the pump flows the fire suppressant, a time of activation of the pump, or a reason for activating the pump.

15. The AMDS of claim **13**, further comprising a stove power source shutoff configured to cut off power to a stove, wherein the controller is configured to direct the stove power source shutoff to cut power to the stove when the second sensor detects the second parameter.

16. The AMDS of claim **13**, wherein the controller further includes a memory unit configured to store the first parameter detected by the first sensor and the second parameter detected by the second sensor during the course of operating the AMDS.

17. The AMDS of claim **13**, wherein the controller is configured to transmit a signal to a home automation system, wherein the signal indicates to the home automation system that the second sensor has detected the second parameter.

18. The AMDS of claim **13**, wherein the controller is configured to transition the pump from a deactivated state to an activated state when the second sensor detects the second parameter.

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